



# Mark Scheme (Results)

June 2017

IAL Chemistry (WCH06/01)  
Chemistry Laboratory Skills II

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Summer 2017

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## General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:
  - i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
  - ii) select and use a form and style of writing appropriate to purpose and to complex subject matter
  - iii) organise information clearly and coherently, using specialist vocabulary when appropriate

## Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:

- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.

( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.

Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.

ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

## Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.

Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

| Question Number | Acceptable Answer                                                                                                                                                                                                                                                                                                                                                                          | Reject    | Mark |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------|
| 1(a)(i)         | <p>(Green solid) turns black<br/>OR<br/>Black solid formed<br/>ALLOW<br/>crystals / precipitate / powder for solid<br/>(1)</p> <p>Colourless liquid (condenses at the mouth of the boiling tube)<br/>ALLOW<br/>steamy fumes / steam / white fumes / condensation<br/>(1)</p> <p>IGNORE<br/>Gas / vapour evolved<br/>Effervescence / bubbling / fizzing<br/>Water / water vapour formed</p> | White gas | (2)  |

| Question Number | Acceptable Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Reject                                                                                                                    | Mark |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|------|
| 1(a)(ii)        | <p><b>EITHER</b><br/>Add (water) to cobalt((II)) chloride / <math>\text{CoCl}_2</math> (paper)<br/>(1)</p> <p>(cobalt chloride) turns (from blue to) pink<br/>(1)</p> <p><b>OR</b><br/>Add (water) to <b>anhydrous</b> copper((II)) sulfate / <math>\text{CuSO}_4</math><br/>(1)</p> <p>(copper(II) sulfate) turns (from white to) blue<br/>(1)</p> <p><b>OR</b><br/>Add (water) to copper((II)) sulfate / <math>\text{CuSO}_4</math><br/>(1)</p> <p>(copper(II) sulfate) turns from white to blue<br/>(1)</p> <p>If name and formula of reagents are given, both must be correct<br/>Ignore formula of product<br/>Observation mark dependent on test reagent being correct (or a near miss)</p> | <p>Boiling temperature is <math>100^\circ\text{C}</math></p> <p>Test with litmus</p> <p>Test with universal indicator</p> | (2)  |

| Question Number  | Acceptable Answer                                                                                                                                                                                                                                                                                                                                                                                              | Reject        | Mark       |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|------------|
| <b>1(a)(iii)</b> | (Bubble the gas through) lime water / calcium hydroxide solution / $\text{Ca(OH)}_2(\text{aq})$ <b>(1)</b><br><br>which turns milky / cloudy / chalky / forms white precipitate <b>(1)</b><br><br>If name and formula are given, both must be correct<br><br>Observation mark dependent on test reagent being correct (or a near miss)<br><br>IGNORE<br>Extinguishes a lighted splint<br>Blue litmus turns red | Smokey/turbid | <b>(2)</b> |

| Question Number | Acceptable Answer                                                                                                                                                                               | Reject                             | Mark       |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|------------|
| <b>1(b)(i)</b>  | Effervescence / bubbling / fizzing <b>(1)</b><br><br>IGNORE<br>Gas / $\text{CO}_2$ / carbon dioxide evolved / steamy fumes<br><br>(Green solid dissolves and) a blue solution formed <b>(1)</b> | Just 'turns blue' blue precipitate | <b>(2)</b> |

| Question Number | Acceptable Answer                                                                                                                                                                               | Reject | Mark       |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------|
| <b>1(b)(ii)</b> | $\text{Cu}_2\text{CO}_3(\text{OH})_2 + 2\text{H}_2\text{SO}_4 \rightarrow 2\text{CuSO}_4 + 3\text{H}_2\text{O} + \text{CO}_2$<br>OR<br>multiples<br><br>Ignore state symbols even if incorrect. |        | <b>(1)</b> |

| Question Number  | Acceptable Answer                                                                                                                                     | Reject | Mark       |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------|
| <b>1(b)(iii)</b> | (aqueous) Ammonia / $\text{NH}_3(\text{aq})$<br><br>ALLOW<br>$\text{NH}_4\text{OH}$ / amine by name or formula<br><br>IGNORE<br>Dilute / concentrated |        | <b>(1)</b> |

| Question Number | Acceptable Answer                                                                                                                                                                                                                                                                                    | Reject                                                                                                                     | Mark       |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|------------|
| <b>1(c)(i)</b>  | (Anhydrous) calcium chloride / $\text{CaCl}_2$ /<br>magnesium sulfate / $\text{MgSO}_4$ / silica gel / sodium sulfate / $\text{Na}_2\text{SO}_4$ / calcium sulfate / $\text{CaSO}_4$<br><br>ALLOW<br>Phosphorus(V) oxide / phosphorus pentoxide / $\text{P}_4\text{O}_{10}$ / $\text{P}_2\text{O}_5$ | $\text{NaOH}$ / $\text{KOH}$ / $\text{CaO}$ / $\text{CuSO}_4$ / $\text{CoCl}_2$ / $\text{H}_2\text{SO}_4$<br>Just 'silica' | <b>(1)</b> |

| Question Number | Acceptable Answer                                                                                                                              | Reject                                                        | Mark       |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|------------|
| <b>1(c)(ii)</b> | Soda lime / sodium hydroxide / $\text{NaOH}$ / potassium hydroxide / $\text{KOH}$<br><br>ALLOW<br>Calcium hydroxide / $\text{Ca}(\text{OH})_2$ | $\text{CaO}$ / calcium oxide / any solutions<br><br>Limewater | <b>(1)</b> |

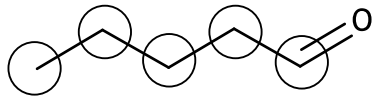
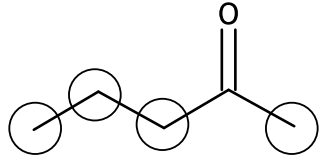
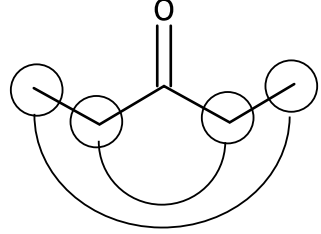
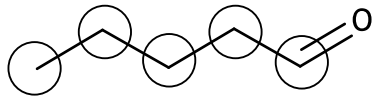
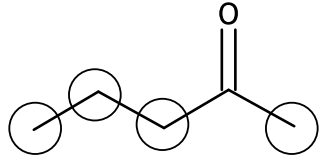
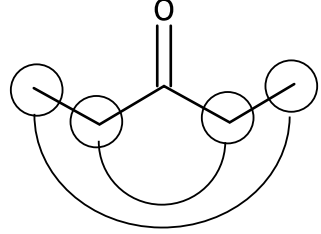
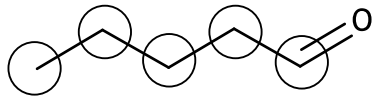
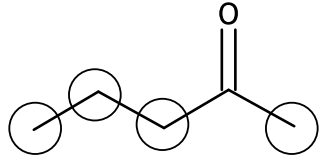
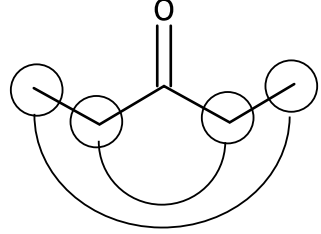
| Question Number  | Acceptable Answer                                                                                                                                                                                                                                                                                                                   | Reject                       | Mark       |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|------------|
| <b>1(c)(iii)</b> | Heat malachite solid /sample to constant mass<br>OR<br>Heat malachite, weigh and heat, re-weigh until two successive weighings are the same<br><br>ALLOW<br>No change in mass of malachite / test tube<br>OR<br>No change in mass of X / Y / U-tube(s)<br><br>IGNORE<br>No further change in colour<br>No more gas / water produced | Just 'heat to constant mass' | <b>(1)</b> |

| Question Number | Acceptable Answer                                                                                                                                                                                                                                                                                                                                                                                                                                  | Reject | Mark       |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------|
| <b>1(c)(iv)</b> | Mass of malachite / sample at the start<br>OR<br>Mass of residue/black solid/copper(II) oxide after heating<br>IGNORE<br>Change in mass of malachite <b>(1)</b><br><br><b>Change</b> in mass of solid <b>X and</b> solid <b>Y</b><br>OR<br>Mass of <b>both</b> U tubes at the start <b>and</b> finish of the experiment <b>(1)</b><br><br>IGNORE<br>Masses / amounts / moles of malachite<br>Masses / amounts / moles of water and CO <sub>2</sub> |        | <b>(2)</b> |

**(Total for Question 1 = 15 marks)**

| Question Number              | Acceptable Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Reject                                      | Mark                      |  |  |          |              |              |                              |                           |                           |                           |                  |                                      |           |           |               |           |                                             |           |                                           |            |
|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|---------------------------|--|--|----------|--------------|--------------|------------------------------|---------------------------|---------------------------|---------------------------|------------------|--------------------------------------|-----------|-----------|---------------|-----------|---------------------------------------------|-----------|-------------------------------------------|------------|
| <b>2(a)(i)</b>               | <table border="1"> <thead> <tr> <th rowspan="2">Test</th><th colspan="3">Observations</th></tr> <tr> <th>pentanal</th><th>pentan-2-one</th><th>pentan-3-one</th></tr> </thead> <tbody> <tr> <td>2,4-dinitro-phenyl-hydrazine</td><td>red / orange / yellow ppt</td><td>red / orange / yellow ppt</td><td>red / orange / yellow ppt</td></tr> <tr> <td>Tollens' reagent</td><td>silver mirror / black ppt / grey ppt</td><td>no change</td><td>no change</td></tr> <tr> <td>Iodoform test</td><td>no change</td><td>(pale) yellow ppt<br/>OR<br/>antiseptic smell</td><td>no change</td></tr> </tbody> </table> <p>2,4-DNPH tests</p> <p>all three correct scores 2<br/>ALLOW<br/>two correct scores 1<br/>three precipitates but no / incorrect colour scores 1<br/>three 'solutions' scores zero <b>(2)</b></p> <p>each other positive test scores 1 <b>(2)</b></p> <p>Penalise <b>omission</b> of ppt in Tollens' and iodoform tests once only</p> <p>Four <b>correct</b> 'no change' scores 1 mark<br/>IGNORE<br/>Extra 'no changes' <b>(1)</b></p> | Test                                        | Observations              |  |  | pentanal | pentan-2-one | pentan-3-one | 2,4-dinitro-phenyl-hydrazine | red / orange / yellow ppt | red / orange / yellow ppt | red / orange / yellow ppt | Tollens' reagent | silver mirror / black ppt / grey ppt | no change | no change | Iodoform test | no change | (pale) yellow ppt<br>OR<br>antiseptic smell | no change | <p>solution for ppt</p> <p>orange ppt</p> | <b>(5)</b> |
| Test                         | Observations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                             |                           |  |  |          |              |              |                              |                           |                           |                           |                  |                                      |           |           |               |           |                                             |           |                                           |            |
|                              | pentanal                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | pentan-2-one                                | pentan-3-one              |  |  |          |              |              |                              |                           |                           |                           |                  |                                      |           |           |               |           |                                             |           |                                           |            |
| 2,4-dinitro-phenyl-hydrazine | red / orange / yellow ppt                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | red / orange / yellow ppt                   | red / orange / yellow ppt |  |  |          |              |              |                              |                           |                           |                           |                  |                                      |           |           |               |           |                                             |           |                                           |            |
| Tollens' reagent             | silver mirror / black ppt / grey ppt                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | no change                                   | no change                 |  |  |          |              |              |                              |                           |                           |                           |                  |                                      |           |           |               |           |                                             |           |                                           |            |
| Iodoform test                | no change                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | (pale) yellow ppt<br>OR<br>antiseptic smell | no change                 |  |  |          |              |              |                              |                           |                           |                           |                  |                                      |           |           |               |           |                                             |           |                                           |            |

| Question Number | Acceptable Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Reject                                                         | Mark       |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|------------|
| <b>2(a)(ii)</b> | <p>The two methods must be marked separately</p> <p><b>MP1 and MP2 Method 1</b></p> <p>Iodine (solution) / <math>I_2(aq)</math> / iodine in potassium iodide (solution) <b>(1)</b></p> <p>Sodium hydroxide (solution) / <math>NaOH(aq)</math><br/>OR<br/>Potassium hydroxide (solution) / <math>KOH(aq)</math> <b>(1)</b></p> <p><b>MP1 and MP2 Method 2</b></p> <p>Add potassium iodide / <math>KI(aq)</math><br/>ALLOW<br/>Add sodium iodide / <math>NaI(aq)</math> <b>(1)</b></p> <p>Add sodium chlorate(I) / sodium hypochlorite / <math>NaOCl(aq)</math> <b>(1)</b></p> <p><b>MP3</b></p> <p>MP3 is dependent on two correct reagents from a single method or on 'iodine and alkali' in method 1</p> <p>Any indication that the inorganic reagents are in (aqueous) solution including "dilute"</p> <p>OR (Method 1 only)<br/>Add alkali to iodine until (brown solution) turns colourless</p> <p>OR<br/>Warm<br/>OR<br/>Heat in a water bath</p> <p>ALLOW<br/>Just 'heat' <b>(1)</b></p> | <p>Just 'alkali'</p> <p>Ethanol as a solvent</p> <p>Reflux</p> | <b>(3)</b> |

| Question Number                                                                    | Acceptable Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Reject    | Mark                          |  |                                                                                   |   |     |                                                                                   |   |     |                                                                                    |   |     |  |     |
|------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------------------------|--|-----------------------------------------------------------------------------------|---|-----|-----------------------------------------------------------------------------------|---|-----|------------------------------------------------------------------------------------|---|-----|--|-----|
| 2(b)                                                                               | <table><tr><th>Structure</th><th>Number of Proton Environments</th><th></th></tr><tr><td></td><td>5</td><td>(1)</td></tr><tr><td></td><td>4</td><td>(1)</td></tr><tr><td></td><td>2</td><td>(1)</td></tr></table> <p>If all three marks are not awarded</p> <p>All three diagrams correct with <b>correct</b> linked proton environments scores 2</p> <p>All three diagrams correct showing proton environments only scores 1</p> <p>All three 'numbers of proton environments' correct scores 1 mark</p> <p>ALLOW<br/>any indication of identical environments in propan-3-one</p> | Structure | Number of Proton Environments |  |  | 5 | (1) |  | 4 | (1) |  | 2 | (1) |  | (3) |
| Structure                                                                          | Number of Proton Environments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |                               |  |                                                                                   |   |     |                                                                                   |   |     |                                                                                    |   |     |  |     |
|   | 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | (1)       |                               |  |                                                                                   |   |     |                                                                                   |   |     |                                                                                    |   |     |  |     |
|   | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | (1)       |                               |  |                                                                                   |   |     |                                                                                   |   |     |                                                                                    |   |     |  |     |
|  | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | (1)       |                               |  |                                                                                   |   |     |                                                                                   |   |     |                                                                                    |   |     |  |     |

**(Total for Question 2 = 11 marks)**

| Question Number | Acceptable Answer                                                                             | Reject                                                     | Mark       |
|-----------------|-----------------------------------------------------------------------------------------------|------------------------------------------------------------|------------|
| <b>3(a)(i)</b>  | (High resistance) voltmeter<br>OR<br>Potentiometer<br><br>ALLOW<br>high resistivity voltmeter | Low resistance voltmeter<br>Galvanometer<br>Voltmeter cell | <b>(1)</b> |

| Question Number | Acceptable Answer | Reject                                       | Mark       |
|-----------------|-------------------|----------------------------------------------|------------|
| <b>3(a)(ii)</b> | Copper / Cu       | $\text{Cu}^{2+}$ /<br>Cu and any other metal | <b>(1)</b> |

| Question Number  | Acceptable Answer | Reject | Mark       |
|------------------|-------------------|--------|------------|
| <b>3(a)(iii)</b> | Platinum / Pt     |        | <b>(1)</b> |

| Question Number | Acceptable Answer                                                                                                                                                                       | Reject                         | Mark       |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|------------|
| <b>3(a)(iv)</b> | Filter paper <b>(1)</b><br><br>IGNORE<br>salt bridge<br><br>(soaked in saturated solution of)<br>potassium nitrate / $\text{KNO}_3$<br>ALLOW<br>$\text{NaNO}_3$ / KCl / NaCl <b>(1)</b> | Just "paper"<br><br><br>solids | <b>(2)</b> |

| Question Number | Acceptable Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Reject | Mark       |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------|
| <b>3(a)(v)</b>  | <p>Solution containing <b>soluble</b> iron(II) and iron(III) compounds identified by name or formula<br/>e.g. iron(II) sulfate / <math>\text{FeSO}_4</math> <b>and</b> iron(III) chloride / <math>\text{FeCl}_3</math></p> <p>ALLOW<br/>Solution containing <math>\text{Fe}^{2+}</math> <b>and</b> <math>\text{Fe}^{3+}</math> <b>(1)</b></p> <p><b>Both</b> solutions <math>1 \text{ mol dm}^{-3}</math> in iron ions</p> <p>ALLOW<br/>Solutions equimolar in iron <b>ions</b> <b>(1)</b></p> <p>Name or formula of <b>soluble</b> iron compounds <b>with</b> 1 mole of <math>\text{Fe}^{x+}</math> per mole of both compounds e.g. <math>0.5 \text{ mol dm}^{-3} \text{Fe}_2(\text{SO}_4)_3</math> and <math>1.0 \text{ mol dm}^{-3} \text{FeSO}_4</math> scores (2) marks</p> <p>If no other mark scored<br/><math>1.0 \text{ mol dm}^{-3} \text{Fe}^{2+} / \text{Fe}^{3+}</math><br/>OR<br/><math>0.5 \text{ mol dm}^{-3} \text{Fe}_2(\text{SO}_4)_3</math> <b>OR</b> <math>1.0 \text{ mol dm}^{-3} \text{FeSO}_4</math> scores (1) marks</p> |        | <b>(2)</b> |

| Question Number | Acceptable Answer                                                                                                                                                                                                                            | Reject                                                              | Mark       |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|------------|
| <b>3(b)(i)</b>  | <p><math>2\text{Fe}^{3+} + \text{Cu} \rightarrow 2\text{Fe}^{2+} + \text{Cu}^{2+}</math><br/>OR<br/>Multiples<br/>OR<br/><math>\rightleftharpoons</math> for <math>\rightarrow</math></p> <p>IGNORE<br/>State symbols even if incorrect.</p> | <p>Reverse reaction</p> <p>Equations with uncancelled electrons</p> | <b>(1)</b> |

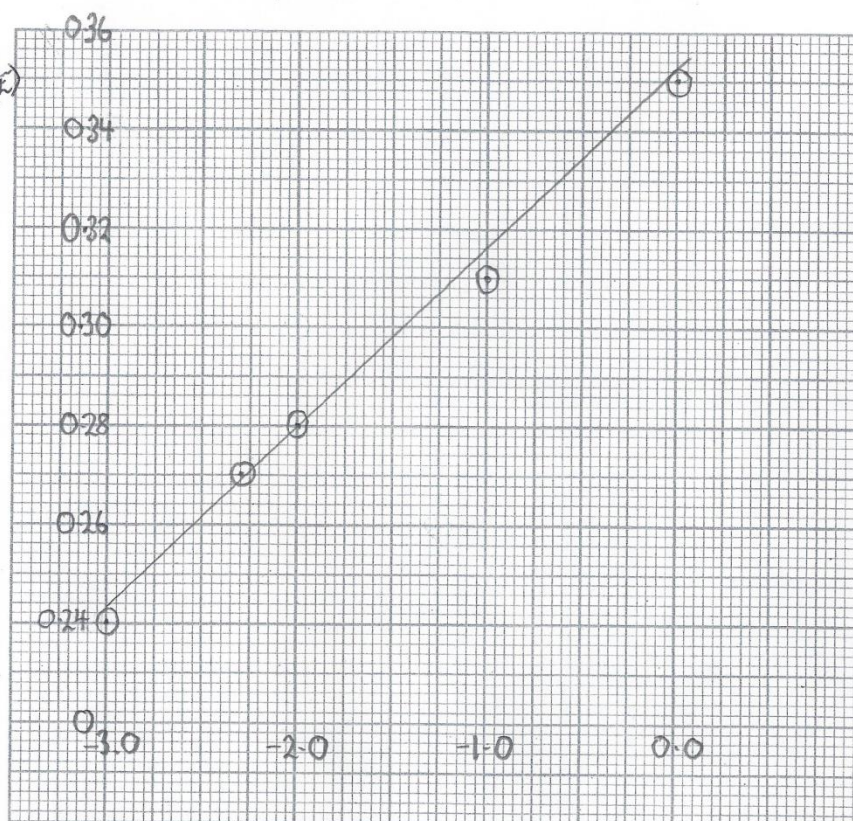
| Question Number | Acceptable Answer                                                                                                                                                                                                                                                                                                                                                                                                                           | Reject                    | Mark       |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|------------|
| <b>3(b)(ii)</b> | <p>(literature value) <math>E^\circ_{\text{cell}} = 0.77 - 0.34 = (+)0.43</math> (V)</p> <p>TE on reverse reaction in (b)(i) (<math>E^\circ_{\text{cell}} = -0.43</math> (V)) <b>(1)</b></p> <p>% error = <math>100 \times (0.43 - 0.35) \div 0.43 = 18.6</math> %</p> <p>TE on incorrect calculation of <math>E^\circ_{\text{cell}}</math> but literature value <b>must</b> be the denominator <b>(1)</b></p> <p>IGNORE SF except 1 SF</p> | <p>22.9 %</p> <p>20 %</p> | <b>(2)</b> |

| Question Number | Acceptable Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Reject                                                                               | Mark       |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|------------|
| <b>3(c)(i)</b>  | <p><b>MP1</b><br/>Use a <b>pipette</b> to measure 25.0 (or 10.0) <math>\text{cm}^3</math> of the 1.0 <math>\text{mol dm}^{-3}</math> copper(II) sulfate solution<br/>ALLOW<br/>Burette <b>(1)</b></p> <p><b>MP2</b><br/>Transfer this to a 250.0 (or 100.0) <math>\text{cm}^3</math> volumetric / graduated / standard flask <b>(1)</b></p> <p><b>MP3</b><br/>Make solution up to the mark with (distilled) water <b>and then</b> mix / shake / invert <b>(1)</b></p> <p>If MP1 and MP2 not awarded, mention of pipette and volumetric flask scores 1</p> | <p>Measuring cylinder / beaker / syringe</p> <p>No mention of appropriate volume</p> | <b>(3)</b> |

| Question Number | Acceptable Answer                                                                                                                                                                                                                                                                               | Reject | Mark       |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------|
| <b>3(c)(ii)</b> | <p>Increases the possibility of contamination of <math>\text{Cu}^{2+}</math> / <math>\text{CuSO}_4</math> due to residues from earlier experiments in beakers or on salt bridge / electrodes</p> <p>ALLOW<br/>Reverse explanation i.e. low concentration to high reduces contamination risk</p> |        | <b>(1)</b> |

| Question Number  | Acceptable Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Reject                                                                                                             | Mark       |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|------------|
| <b>3(c)(iii)</b> | <p>See below for example</p> <p>Choice of scale to cover at least half the grid in both directions <b>and</b> labelled axes with units on y axis, which may be labelled E/V. x axis may be <math>\log_{10}[\text{Cu}^{2+}(\text{aq})]</math> or <math>\log_{10}[\text{Cu}^{2+}]</math> or <math>\log_{10}[\text{CuSO}_4(\text{aq})]</math> or <math>\log_{10}[\text{CuSO}_4]</math> <b>(1)</b></p> <p>All points given in table correctly plotted TE on axes used <b>(1)</b></p> <p>Any sensible smooth best fit <b>straight</b> line <b>(1)</b></p> | <p>Non-linear scale scores (0)</p> <p>Any units on x-axis</p> <p>log scale reversed</p> <p>point to point line</p> | <b>(3)</b> |

Electrode Potential (V)



$\log_{10}[\text{CuSO}_4(\text{aq})]$

| Question Number | Acceptable Answer                                                                                                                                                                                                                                                                                                                                                                                                                                             | Reject                                  | Mark       |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|------------|
| <b>3(c)(iv)</b> | <p>Electrode potential / E is proportional to <math>\log_{10}</math> (concentration of copper(II) ions) / <math>\log_{10}[\text{Cu}^{2+}(\text{aq})]</math></p> <p>OR</p> <p><math>E \propto \log_{10}[\text{Cu}^{2+}(\text{aq})] / \log_{10}[\text{CuSO}_4(\text{aq})]</math></p> <p>ALLOW</p> <p>log / lg for <math>\log_{10}</math></p> <p>IGNORE</p> <p>'directly' / reference to exponential relationships</p> <p>No TE on incorrectly plotted graph</p> | $E \propto [\text{Cu}^{2+}(\text{aq})]$ | <b>(1)</b> |

**(Total for Question 3 = 18 mark)**

| Question Number | Acceptable Answer                                                                             | Reject                  | Mark       |
|-----------------|-----------------------------------------------------------------------------------------------|-------------------------|------------|
| <b>4(a)</b>     | Oxidising<br><br>ALLOW<br>"oxidising agent/liquid"<br>"oxidative" / "oxidating"<br>/"oxidant" | Flammable / inflammable | <b>(1)</b> |

| Question Number | Acceptable Answer                                                                                                                                                                                                                                         | Reject                                                                 | Mark       |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|------------|
| <b>4(b)</b>     | Reaction (between concentrated nitric and sulfuric acid) is (very) exothermic<br><br>ALLOW<br>Generates a lot of heat<br><br>IGNORE<br>Vigorous / violent / prevents splashing / volatile<br>To slow down the reaction / prevent high rise in temperature | Reaction between sulfuric acid and water<br><br>To quench the reaction | <b>(1)</b> |

| Question Number | Acceptable Answer                                                                                                                                                                                             | Reject | Mark       |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------|
| <b>4(c)</b>     | To minimise / prevent formation of 1-methyl-2,4-dinitrobenzene<br>OR<br>dinitration / trinitration / further substitution<br>OR<br>To ensure (only) monosubstitution<br><br>IGNORE<br>Further reactions occur |        | <b>(1)</b> |

| Question Number | Acceptable Answer                                                                                                                  | Reject | Mark       |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------|--------|------------|
| <b>4(d)</b>     | To neutralise / react with / remove (remaining traces of / excess) acid / nitric acid / sulphuric acid<br><br>IGNORE<br>Impurities |        | <b>(1)</b> |

| Question Number | Acceptable Answer                                                    | Reject                                         | Mark       |
|-----------------|----------------------------------------------------------------------|------------------------------------------------|------------|
| <b>4(e)</b>     | Lower value (from) 218-221 (°C)<br><br>Upper value (to) 223-226 (°C) | 222°C on its own or as one of the range values | <b>(1)</b> |

| Question Number | Acceptable Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Reject                          | Mark       |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|------------|
| <b>4(f)</b>     | <p><b>Either</b><br/>                     (Remove 1-methyl-4-nitrobenzene by) further distillation at (about) 240°C</p> <p>ALLOW<br/>                     between 238°C and 290 °C<br/>                     OR<br/>                     less than 300°C<br/>                     (and then recrystallisation / crystallisation from the distillation residue)</p> <p><b>Or</b><br/>                     Further distillation / fractional distillation <b>and</b> followed by recrystallisation / crystallisation from the distillation residue</p> <p>ALLOW<br/>                     Steam distillation <b>and</b> because 1-methyl-2,4-dinitrobenzene decomposes around its boiling temperature</p> | Distillation at or above 300 °C | <b>(1)</b> |

**(Total for Question 4 = 6 marks)**

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**TOTAL FOR PAPER = 50 MARKS**

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